A Systematic Review of Flow Training on Flow States and Performance in Elite Athletes

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Abstract

This systematic review aimed to examine the effects of flow training on flow states and performance outcomes in elite athletes. PRISMA guidelines were employed and a search on SPORTDiscus, PsycINFO, SAGE journals online, INGENTA connect, and Google Scholar was completed in December 2015. Six pre-experimental studies using single subject designs and one experimental study, published between 2005 and 2014, found positive effects of psychological interventions improving flow states and performance, with four studies reporting significant or sizeable increases in flow states, and all studies reporting either quantitative or qualitative increases in performance. Interventions included hypnosis, imagery, music, and client-centred pre-performance routines. Further rigorous, experimental research with larger sample sizes is required to establish conclusive relationships between flow states and performance. Research recommendations include interventions matched to theoretical dimensions of flow, and the use of multi-skilled and cognitive restructuring interventions. Furthermore, measures of flow intensity and frequency are advised to determine activity specific requirements, as well as dimensional and global flow scores to further understand how specific interventions are increasing flow.

Keywords: Flow, Elite Athletes, Performance, Review, Training, Interventions

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Introduction

The flow state has emerged as a dominant theme in positive psychology, in areas relating to engagement and happiness (Csikszentmihalyi, 1990; Seligman, 2012), positive performance outcomes (Jackson & Roberts, 1992), and optimal experiences (Csikszentmihalyi, 1990). Csikszentmihalyi (1975, 2002) first described the flow state as a deeply rewarding psychological state of optimal experience, in which the person is fully immersed in an activity to the exclusion of all other thoughts and emotions. Csikszentmihalyi (1990) described flow conceptually through nine dimensions: 1) Challenge-skills balance; 2) Merging of action and awareness; 3) Clear goals; 4) Unambiguous feedback; 5) Concentration on the task at hand; 6) Sense of control; 7) Loss of self-consciousness; 8) Transformation of time; and 9) Autotelic experience. Csikszentmihalyi theorized that the more dimensions an individual experienced, the greater the flow intensity. This flow model has proven robust across lines of culture, class, and gender (Nakamura & Csikszentmihalyi, 2002). Equally, the model has been confirmed in multiple domains such as the visual arts (Reynolds & Prior, 2006), music (Bakker, 2005), recreational activities (Havitz & Mannell, 2005), business (Csikszentmihalyi, 2004), aesthetic experiences (Csikszentmihalyi & Robinson, 1990), and competitive sport (Jackson, 1992, 1996; Swann, Keegan, Piggott & Crust, 2012). Most notably, the flow state is a valued experience for athletes (Jackson & Roberts, 1992), often pushing them to their performance limits (Jackson & Csikszentmihalyi, 1999). Consequently, a multitude of studies have linked increases in flow with performance (e.g., Jackson & Csikszentmihalyi, 1999; Pates, Oliver, & Maynard, 2001). For example, Flett (2015) reported that increases in flow correlated to increases in performance in tennis players and that flow is more function- and performance orientated than it is reflective of positive and optimal experience. Notwithstanding, the flow state is a distinct concept from the outcomes of peak performance (Harmison, 2011). For example, one can perform well but not be in an optimal state of flow (Jackson & Csikszentmihalyi, 1999). Thus, indicating a training program devised to increase flow may be similar but not identical to performance training.

While the descriptive characteristics and antecedents of flow have been widely studied, applied literature on flow training has been relatively scant; even though research surrounding how performance training effects performance is abundant (Judge, Bell, Bellar & Wanless, 2010; Weinberg & Comar, 1994). Since flow is an optimal psychological state that underpins an athlete's greatest and most memorable performances (Jackson & Csikszentmihalyi, 1999), the limited research that is in existence may be very applicable to applied psychologists. Indeed, Swann, Keegan, Piggott and Crust's (2012) review on flow research reported that 72% of elite athletes perceived obtaining flow was in their control, while 81% perceived they could restore flow after disruption. The few studies measuring changes in flow have predominantly examined samples of high performing or elite athletes as participants. Although flow can be achieved by the populous, this focus on athletes has been justified through the selection of information rich and relevant cases, as flow is more frequently experienced in elite athletes due to their continual opportunity during competitions to meet the dimensional 'skill-challenge' balance required for flow (Jackson, 1995). To date, other than Swann et al.'s (2012) broader review on flow, no specific review examining training that has primarily been designed to increase flow experiences and the subsequent effects on flow *and* performance outcomes has been carried out. Nevertheless, the ability to enhance an athlete's flow experience is practically an exciting prospect, especially to further improve the performance of elite athletes. Therefore, in the aim of filling this gap in the literature, this review aims to examine the effects of flow training on flow states and performance outcomes in elite athletes.

Method

This systematic review followed PRISMA guidelines (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) (Moher, Liberati, Tetzlaff, & Altman, 2009).

Search Criteria

This review searched the following databases: SPORTDiscus, PsycINFO, SAGE journals online, INGENTA connect, and Google Scholar. In addition, hand searching was conducted by drawing from the reference lists of included articles. Preliminary searches using the keywords 'flow state', 'performance', and 'athletes' identified a number of 'negative keywords' that were removed from final searches, including: water, blood, cash, fluid, optical, gas, air, liquid, traffic, trade, work, coronary, nutrient, velocity, turbine, cardiac, chart.

Inclusion / Exclusions

The literature included in this review met the following criteria: (i) published in peer-reviewed literature; (ii) published in English; (iii) included a flow training component, whereby 'training' included any cognitive learning or purposeful learning of skills (Kent, 2006); (iv) examined elite athletes. For this review, 'elite athletes' included a continuum of athletes ranging from semi-elite (e.g., high performance youth development programs) to word-class elite (e.g., winning consistently at the Olympics) as defined by Swann, Moran, and Piggot (2014). No restrictions were placed on dates or countries. Performance outcomes included both self-perceived and objective measures. Studies not measuring flow states or including original data were excluded.

Data Synthesis

The following data was extracted into a predefined table: author, date, sample demographics, study method, flow measures, performance measures and results (Brooker, Dooren, McPherson, Lennox & Ware, 2015). See Table 1 for study findings. Findings are presented below in Campbell and Stanley's (1963) pre-experimental and experimental categories.

Findings

Search Returns

Database searches returned a total of 2942 articles. After the removal of duplicates and article titles and abstracts not adhering to the inclusion criteria, thirty-nine articles were then screened fully. A further review then excluded thirty-two articles for the following reasons: not using original data (n = 1), foreign language (n = 1) not studying elite athletes (n = 23), not employing flow training (n = 6) and not measuring flow (n = 1). See Figure 1 for a breakdown of excluded articles. The seven included articles studied a variety of sports including golf, soccer, cycling, tennis, track and field, rugby and hockey. Participants were located in England, Ireland or Australia with a median age of 21.5 years. Flow state scales (Jackson & Eklund, 2002; Jackson & Marsh, 1996) were exclusively used to measure flow in all studies, whilst performance measurements included subjective and objective sport-specific measurements. These measures included…. Given the various methods, interventions, and measures used, the results for flow states and performance could not be aggregated. These results are presented in a descriptive manner below.

Pre Experimental Findings

Six out of the seven included studies were pre-experimental, with five adopting a single subject (SS) multiple baseline design (Nicholls et al., 2005; Pain et al., 2011; Lindsay et al., 2005; Koehn et al., 2014; and Pates et al., 2012), and one using a SS design relying on one participant (Pates and Cowen, 2013). Nicholls et al. (2005) and Koehn et al. (2014)

investigated imagery interventions in golfers and tennis players respectively, whilst Pain et al. (2011) examined music and imagery interventions in soccer players. Pates and Cowan (2013) and Lindsay et al. (2005) investigated the effects of hypnotic anchoring in a golfer and cyclists respectively, whilst Pates et al. (2012) examined the effects of client-centered pre-shot routines involving different psychological skills for each golfer (see Table 1 for intervention details). All studies integrated social validation techniques.

Effect on Flow

All studies acknowledged Csikszentmihalyi's (1975 & 2000) model of flow. However, Koehn et al. (2014), Lindsay et al. (2005), Pates and Cowan (2013), and Pates et al. (2012) referred to different definitions of flow, whilst Nicholls et al. (2005) and Pain et al. (2011) did not provide a definition. All pre-experimental studies used the Flow State Scale (FSS) or updated Flow State Scale-2 (FSS-2) (Jackson & Marsh, 1996; Jackson & Eklund, 2002), whilst only one study employed the Dispositional Flow Scale-2 (DFS-2) (Jackson & Eklund, 2002). All studies showed increases in flow states; however, not all conclusively (see Table 1). Nicholls et al. (2005) found small increases in flow, and argued that the ecological and competitive environment may have accounted for a high degree of overlapping data points and a short unstable baseline. Pain et al. (2011) also reported questionable baseline stability, although reported mean sizeable effects (48%) when asynchronous music was combined with imagery in the intervention. Pates and Cowan (2013), Lindsay et al. (2005), and Pates et al. (2012) found a mean global flow score increase with few or no overlapping data points, but possibilities of a Hawthorne effect. Koehn et al. (2014) found three of the four participants significantly increased flow scores (binominal test), whereas the other participant was affected by confounding and situational factors within the competition setting. No studies directly assessed dimensional scores, however, Koehn et al. (2014) reported dimensional support with participants stating they felt in 'control', had 'clear goals', and 'focused' better.

Effect on Performance

Three studies assessed objective measures of performance only (Nicholls et al., 2005; Pates and Cowen, 2013; and Koehn et al., 2014), one study assessed subjective measures only (Pain et al., 2011) , and two studies measured both subjective and objective measures (Pates et al., 2012; Lindsay et al., 2005). Nicholls et al. (2005) found all four participants improved consistency of successful golf shots (ranging from 4% to 20%), however , study limitations included the use of only one performance indicator. Pain et al. (2011) reported mean sizeable effects (40%) in perceived performance indicators for asynchronous music combined with imagery interventions; social validation techniques supported their findings. Pates and Cowan (2013) found a mean performance increase (6%) for stroke averages, and revealed that participants recognised an increase in performance, prize money and relaxation. Lindsay et al. (2005) revealed that two participants increased mean ranking points (1.3 to 8.7; 0 to 7.2), and no effect was found for participant three, and self-assessed performance analysis revealed all participants perceived a mean improvement (49%). Koehn et al. (2014) found all participants increased national rankings and significantly increased performance, with one exemption, in which a ceiling effect was argued to be the reason for insignificance. Pates et al. (2012) reported immediate increases in stroke averages, perceived performance, prize money earnings, and world rankings.

Experimental Findings

Effect on Flow

Aherne, Moran and Lonsdale (2011) studies the effects of mindfulness interventions on a variety of athletes. Aherne et al. (2011) used a unique description of flow, and reported a significant interaction ($F = 11.49$, $p < .05$) between the intervention and post intervention global flow scores using the FFS-2 long scale. Follow-up t tests indicated no significant difference ($p > .05$) between the experimental and control groups during baseline but a large difference ($p < .05$, $d = 1.66$) after the intervention. The study's limitations included a possible Type II error resulting from the small sample size, and a lack of a distracter task for the control group. The study reported significant dimensional score changes for 'clear goals' and 'sense of control', whilst 'unambiguous feedback' and 'time transformation' showed non-significant increases.

Effect on Performance.

Performance data was not analysed, however, the authors reported that participants' comments suggested an increases in certain aspects of peak performance.

Discussion

The purpose of this systematic review was to examine the effects of flow training on flow states and performance outcomes in elite athletes. Four out of the seven studies reported significant or sizeable percentage increases in *flow states*, with the others suggesting positive, yet inconclusive, results. All studies reported either quantitative or qualitative increases in *performance*, and demonstrated rigour in their methodology. However, six out of the seven studies were non-experimental using small sample sizes, with only Aherne et al. (2011) using a separate control group, therefore, this review cannot conclusively conclude that a positive and beneficial relationship between flow training and flow or performance exists. However, in light of several positive results it is recommend that future research further examine the effects of flow training. Specifically, experimental research that employs larger sample sizes, greater rigour, and comparisons with varying control groups to determine clear correlational relationships between the interventions and independent variables.

Study Design

Specifically, single-subject (SS) designs were used for six out of seven studies, with multiple-baseline (MB) designs accounting for five studies, suggesting a SSMB design is an accessible and efficient design for this research type. Perhaps, also proposing that gathering large data sets for in this domain may be practically difficult. This may also be representative of the time intensive interventions deployed. Until such time that flow training is more defined and consistent in type, a 'gold standard' design for flow training cannot be selected, as design will need to be based around the intervention.

Flow and Performance

None of the studies reported a relationship between the two dependent variables: flow and performance. Consequently, these findings don't conclusively support correlational findings that flow is the psychological state underlying peak performance (Jackson & Robert, 1992; Jackson et al., 2001; Flett, 2015). Future studies are encouraged to adopt larger sample sizes, and report quantitative findings, so correlational and directional relationships between flow and performance can be clarified.

Limited Research

Literature on flow training in elite athletes is limited, and understanding the causes of this limitation may help to generate further research. Six of the studies occurred in Great Britain and one in Australia, which is disproportionate to general global research on flow, so perhaps regional funding to support such work is scant. All papers were published in the last decade with five in the last five years, suggesting an increased interest in this area and hope for future related studies. The sample of elite athletes are well research in other domains (Swann et al., 2015), so sample recruitment is unlikely to be a barrier. The search process found 25 additional related flow training studies in different samples other than elite athletes that did not meet the inclusion criteria, which may provide supplementary data, and thus a suggestion for further literature synthesis.

Type of Intervention

The type of interventions varied greatly with imagery and hypnosis more widely used. Interestingly, Pain et al. (2011) found imagery to only be effective when combined with music, thus suggesting the results of the imagery only studies may have been limited due to intervention selection. Intervention justification was articulated, however, the majority of reasons surrounded combating established inhibitors to flow and encouraging facilitating factors. Since antecedents, inhibitors and facilitators to flow can be sport specific, it was surprising that not one study linked the intervention employed with specific theoretical dimensions of flow. Therefore, it is recommended future studies match intervention type with targeted dimensions, which may consequently result in larger effects. The strongest effect on flow was found using a mindfulness intervention (Aherne et al., 2011), however, other studies also showed positive results but did not adopt the same methodological rigour as the experimental design. Therefore, this review can only conclude that flow training is an emerging field and one that requires more research to determine leading intervention types.

Lindsay et al. (2005) suggested a concurrent *cognitive* flow training program might be useful to help participants' concerns over external factors. Similarly, Jackson and Csikszentmihalyi (1999) stated that cognitive perceptions of skills and challenges could be modified to allow flow to occur with greater intensity. Koehn et al.'s (2014) integration of cognitive imagery was the only cognitive focused training found in this review, though the search process found Skaer's (2006) reports of significance when using cognitive behavioural interventions on flow in non-elite athletes. It is suggested future research compare distinct cognitive based flow interventions, such as educational interventions and cognitive perceptual changes of the 'skill-challenge' balance required for flow, to existing interventions showing positive results.

To date, there is no widely recognised flow training skill. Despite the many studies assessing multi-psychological skills training programmes and effects on performance (Blakeslee & Goff, 2007), this approach to flow training is insufficient (Swann et al., 2012). To date, Judge et al.'s (2010) development of a mental periodization plan and Reardon and Gordin's (1999) psychological skills development program are the only two studies the authors are aware of that have looked at a multi-skilled approach to flow. Both of these reports were descriptive and did not test the suggested programs on any samples. Regardless of the training used, it is imperative that the intervention is specifically designed to increase flow states over and above performance, thus making clear any relationship is a result of flow training not performance training. For example, Lindsay et al. (2005) suggested that future research on hypnosis and flow in athletes use multiple control groups with one group receiving the hypnotic intervention of regressing to a past peak performance but not having the emotions associated with flow.

Applying Interventions

Athletes' preparations and performance cues vary greatly not only in style but also temporally (Durand-Bush & Salmela, 2002), and different interventions may have different effects depending on when they are initiated. In this review, interventions were delivered in advance, just before and during the performance, although the exact details were difficult to ascertain. Only Pain et al. (2011) made specific recommendations that music and imagery interventions are best used in the days leading up to the performance, and reported that one of the participants suggested interventions should be repeated at half time for optimum effect. Finding, sustaining, and restoring flow may all require different skills and therefore interventions. Thus, it is important that future studies outline exactly when interventions have been carried out.

Definition of Flow

Due to the seven varying definitions of flow in seven studies, this review recommends that a single working definition of flow be established. Flow shares the same multi-dimensional complexity as the concepts of mental toughness and resilience and equally researchers vary in their definitions, which may result in confusion and incongruent research. Since the theoretical nine dimensions of flow have proven to be robust and widely used by researchers as the accepted model for describing flow (Nakamura & Csikszentmihalyi, 2002), it would be congruent to include these dimensions within a definition. Csikszentmihalyi (1990) stated that all nine dimensions are not necessary to determine flow, however, the more dimensions reported the deeper the flow experience. Unfortunately, research into macro (deep) versus micro (mild) experiences of flow is scant, so defining the parameters of a flow experience is difficult. Additionally, recent sport-specific research has suggested different activities may contain varying dimensional importance and differences (Chavez, 2008; Swann et al., 2012). However, both Jackson and Marsh's (1996) and Sugiyama and Inomata's (2005) dimensional frequency analysis revealed that athletes reported the dimensions 'action and awareness merging', 'concentration on the task at hand', 'autotelic experience', and 'sense of control' over 70% of the time. Therefore, these dimensions could be considered as core dimensions and thus be integral to the working definition.

Measurement of Flow

All studies used FSS scales to measure flow over other methods (Engeser, 2012), which was expected due to the FSS's prominence in sporting literature. However, the timing of measurement fluctuated. Due to the instrument's experience recall methodology, a key protocol is that measures are taken immediately post-event (Jackson & Eklund, 2002).

Idealistic measurement timing may be ecologically challenging, however visibility is key to establishing validity, thus reporting when data is collected is paramount for future reports. Furthermore, activities long in duration may elicit a range of flow experiences and multiple measurements during a single event may be preferential. Multiple ratings can be carried out post activity (Koehn et al., 2014) to avoid performance distractions or at differing times throughout the activity.

Desirability for frequency over intensity may be activity specific, especially in activities of long duration. For example, a golfer may value finding flow throughout the match more beneficial than experience a high intensity of flow during one hole. However, only Nicholls et al. (2005) examined the frequency (DFS-2 scales) of flow as well as the intensity (FSS-2 scales) of flow, even though two other studies examined golfers. Nicholls et al. (2005) reported that one individual increased flow frequency despite flow intensity not improving, which may have been the case in other studies if examined. Determining relationships or whether specific flow training has a greater effect on frequency or intensity and the subsequent effects on performance outcomes is only possible if both instruments are employed, therefore this review recommends both scales are recorded in subsequent research.

Only one study examined dimensional (Csikszentmihalyi, 1990) differences, which is unexpected given this data is inclusive in the collection of global measures. Given recent sport specific dimensional differences to the flow model (Chavez, 2008; Sugiyama & Inomata, 2005), and the need to understand dimensional variance to form a consolidated definition, it is recommended future research report both dimensional and global results.

Measurement of Performance

In one of the only two studies that assessed both objective and subjective performance measures, Lindsay et al. (2005) revealed a variation between objective and subjective scores for participant three. Even though the majority of studies examined objective performance scores, flow is a subjective experience measured using subjective scales, thus subjective performance testing may be more compatible. Furthermore, certain objective performance scores measured, such as ranking data/points employed by Lindsay et al. (2005), can be influenced by external factors regardless of the individual's level of performance. Therefore, it is recommended that both subjective and objective performance measures be deployed to gain further clarification on the true increases in individual performances.

Limitations

This review followed PRISMA guidelines in an attempt to be objective and systematic in its approach (ref for prisma). The limited number of studies and variety of activities examined limits generalisation. Studies were diverse in their performance measures and flow training techniques, thus making comparisons difficult. Furthermore, sample sizes were small, therefore limiting reliability. It is also suggested that for future reviews authors be contacted directly to reduce the above limitations. Additionally, as research into flow training is growing, a further review comparing these findings to non-elite athletes is suggested.

Applied Recommendations

Applied consultants may view these results as very positive. Pates and Cowan (2013) even suggested that their intervention training be integrated into professional societies. All studies reported secondary positive anecdotal outcomes, e.g., enjoyment, commitment, confidence (Koehn et al., 2014), and controlling negative emotions (Pates & Cowan, 2013). This review found common suggestions to screen athletes in order to individualise interventions to the athlete's experience and interests. For example, poor imagers may struggle with imagery (Pain et al., 2011), and negative intervention bias may skew results (Lindsay et al., 2005). Moreover, Pates et al. (2012) stated that the client should be seen as an expert and co-lead intervention development.

Conclusion

While the studies included in this review do not add conclusive evidence, primarily due to a lack of experimental designs, they did show evidence of flow training increasing flow states and performance outcomes in elite athletes. More research is recommended, specifically experimental research with larger sample sizes and rigour that can establish clear relationships. Multi-skilled or cognitive restructuring training provide research opportunities. Researchers are advised to ensure interventions are matched with theoretical flow dimensions, designed to increase flow states primarily over peak performance outcomes, and report on when best applied temporally. Furthermore, the conception of a consistent definition of flow is recommended in the research area, and FSS-2 and DFS-2 instruments should employ immediate post-event measurement and report on dimensional and global scores. Applied findings conclude additional positive experiences of flow training and advantages to tailoring the intervention to the participant.

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Table 1. Extracted data inline with Brooker et al. (2015).

Article	Flow Training	Participants	Training Length	Method	Flow Measure	Flow Results	Performance Measure	Performance Results
Nicholls, Polman & Holt (2005)	Mental Imagery (Motivational General-Mastery)	3 males, 1 female Age 20 to 23 Represented England Golfers	28 rounds of golf 12 weeks	Pre-experimental single subject (SS) ABA design.	Flow State Scale (FSS-2) Long Dispositional Flow Scale (DFS-2) (Jackson & Eklund, 2002)	3 out of 4 increased flow intensity. 4 out of 4 increased mean flow frequency.	% of successful shots during competitive play.	4 out of 4 increased performance.
Pain, Harwood & Anderson (2011)	1) Asynchronous Music and MG-M Imagery 2) Asynchronous Music 3) MG-M Imagery	5 males (UK) Mean age = 20.5 (S.D = 1.6) FA Centre of Excellence Squad Soccer – BUCS competition 2 defenders 2 midfielders 1 striker	13 matches 19 weeks	Pre-experimental SS multi-baseline (MB) design.	FSS - Long (Jackson & Marsh, 1996)	Asynchronous music & imagery had immediate and mean sizeable effects. (48%). Asynchronous music only, and imagery only interventions, resulted in no consistent improvement.	Perceived performance during competitive soccer season. 5 self-selected performance criteria.	Asynchronous music & Imagery had immediate and mean sizeable effects (40%). Asynchronous music only intervention was generally above baseline. Imagery only resulted in no consistent improvement.
Pates 7 Cowan (2013)	Hypnotic anchoring of flow experience followed by seven home sessions (audio tape)	1 male golfer 22 years old European Professional Golf Tour	11 golf events	Pre-experimental SS AB design.	FSS-2 - Long (Jackson & Eklund, 2002)	1 out of 1 flow increased from a mean of 115.5 to 133.7.	Stroke average (low score is better)	1 out of 1 performance increased from a mean of 75.5 to 71.1 (low = better)
Lindsay, Maynard & Thomas (2005)	A hypnotic intervention using a natural trigger, followed by daily home practice (audiotape recording)	2 male (aged 21 and 32) 1 female (aged 23) Mean age = 25 Cyclists Carried a UK ranking between 1 to 28	13 BCF trials	Pre-experimental SS MB design.	FSS (Flow State Scale) (Jackson & Marsh, 1996)	3 out of 3 increased mean scores.	Accumulated competitive points awarded by BCF for each race. Self-assessed performance (based on 1-10 scale).	Participant 1 increased performance from a mean of 1.3 to 8.7 points. Participant 2 increased performance from a mean of 0 points to 7.2. Participant 3 slightly decreased performance from 12.3 to 10 - although more consistency was found. All 3 participants perceived an overall improvement in performance from a mean of 5.7 to 7.5.
Koehn, Morris & Watt (2014)	A tailored imagery script was developed to target critical flow dimensions, namely challenge-skills balance, clear goals, concentration on the task, and sense of control (Koehn et al., 2013)	4 male tennis players Aged 13 to 15 years (M = 14) Nationally ranked Australian athletes	12 weeks 8 or 11 data points (matches)	Pre-experimental SS MB AB design. Binominal tests calculated baseline and post-intervention differences.	FSS-2 - Long (Jackson & Eklund, 2002)	3 out of 4 participants showed significant increases in mean scores, whilst 1 decreased.	Number of winners hit by serves, and forehand and backhand groundstrokes. Participants' ranking-list position.	4 out of 4 participants showed a significant increase in service performance. 4 out of 4 participants increased their groundstroke performance (1 not significant). All four participants increased their national rankings.
Pates, Cowen & Karageorghis (2012)	Client-centered psychological strategy developed into a preshot routine involving imagery, self-talk, muscular relaxation, attentional control, and music recall	3 male European Tour golfers (aged 28-39)	11 data points	Pre-experimental SS MB AB, across subjects design.	FSS-2 - Long (Jackson & Eklund, 2002)	3 out of 3 participants showed an immediate increase in flow states with no overlapping data points.	Stroke average – average score for tournament.	3 out of 3 showed an immediate increase in performance with only a few overlapping data points across subjects. 3 out of 3 revealed a subjective improvement in their performance, prize money earnings, and world rankings.
Aherne, Moran & Lonsdale (2011)	Mindfulness training of Kabat-Zinn 1) Breathing patterns 2) Breath and Body 3) Standing Yoga 4) Body Scan	13 university athletes (9 male – 3 female). National and international level. Part of the High Performance Centre. Mean Age =21 (range = 19-25). Experimental Group: rugby (2), tennis, hammer throw, sprinter, hockey. Control Group: rugby (2), middle distance runner, sprinter, 1 male hockey player, hockey player.	2 data points 6 weeks	Experimental design 2x2 repeated measures ANOVA.	FSS-2 - Long (Jackson & Eklund, 2002)	A significant interaction and follow-up tests showed flow score increases in experimental group, but not in the control group.	N/A	"…our experiment showed that such training led to increases in certain aspects of peak performance."

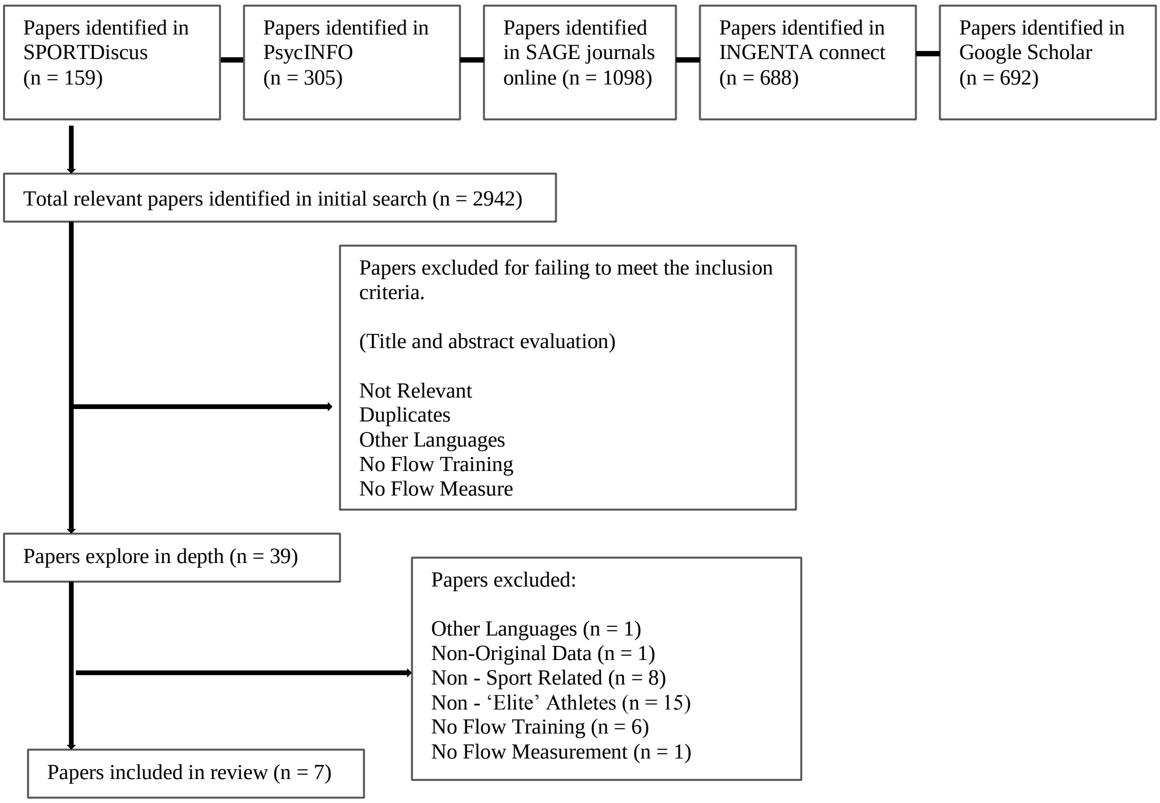

Figure 1. Flowchart of Search process